

Amendment  
Serial No. 10/810,249

Docket 5000-1-552

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**IN THE CLAIMS:**

*Please replace the claims of record with the following full set of claims:*

1 (Currently amended) An Ethernet-PON (Passive Optical Network) accommodating real-time broadcast and/or image signals and configured for providing security for the accommodated signals, comprising:

an OLT (Optical Line Terminal) for:

switching between a plurality of digital broadcast and/or digital image data received from an external broadcast provider, according to respective broadcast and/or image selection information of users received from the users,

dynamically associating a unique scrambling data information in response to a user request, wherein said scrambling data information comprises a scrambling function and associated settings;

scrambling the switched digital data using said unique scrambling data information; on a user-by-user basis,

multiplexing the scrambled digital data into a single signal,

electro-optically converting the multiplexed signal,

electro-optically converting Ethernet communication data received through an IP (Internet Protocol) network and ~~individual user associated~~ the unique scrambling data information associated with the user,

coupling the converted digital and communication data, and

transmitting the coupled signal via said PON;

a plurality of ONTs (Optical Network Terminals), each ONT:

receiving from the OLT an optical signal including said coupled signal,

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separating the received ~~optical~~ coupled signal into said converted digital and Ethernet communication data,

photoelectrically converting the separated data,

selecting broadcast and/or image data from the photoelectrically converted digital data according to the corresponding broadcast and/or image selection information,

descrambling the selected broadcast and/or image data ~~on a user-by-user basis~~ based on said ~~provided~~ scrambling data information provided in said coupled signal to produce an output signal,

outputting the separated, converted Ethernet communication data and said output signal to a corresponding user,

receiving an upstream Ethernet communication signal and said broadcast and/or image selection information from the user, and

outputting to the OLT said upstream Ethernet communication signal and said broadcast and/or image selection information through the path for upstream transmitting said Ethernet communication signal; and

an optical splitter for:

splitting a signal from the OLT among the plural ONTs,

coupling signals from the plural ONTs to create a combined signal, and

transmitting to the OLT said combined signal.

2. (Previously presented) The Ethernet-PON according to claim 1, wherein the OLT receives digital broadcast data and digital image data, and wherein each of the plurality of ONTs includes:

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a wavelength division multiplexing (WDM) coupler for separating an optical signal received from the OLT into an Ethernet communication signal of wavelength  $\lambda_{\text{DOWN}}$  and a broadcast/image signal of wavelength  $\lambda_{\text{B}}$ ;

an optical receiver for receiving the separated Ethernet communication signal of wavelength  $\lambda_{\text{DOWN}}$ , and converting the received signal of wavelength  $\lambda_{\text{DOWN}}$  into an electrical signal;

another optical receiver for receiving the separated broadcast/image signal of  $\lambda_{\text{B}}$ , and converting it into an electrical signal;

an Ethernet-PON ONT function processor for performing ONT functions;

another optical transmitter for receiving broadcast/image selection information and an Ethernet communication signal to be transmitted to the OLT from a corresponding user through the Ethernet-PON ONT function processor, and transmitting said broadcast/image information and a communication signal as an optical signal  $\lambda_{\text{UP}}$ ;

a broadcast/image channel selector & broadcast/image adapter for selecting a broadcast/image signal according to the broadcast/image selection information selected by the user, and recovering an associated original broadcast/image channel;

a descrambler for descrambling the broadcast/image signal recovered through the channel selector & broadcast/image adapter, and transferring the descrambled, recovered signal to the user; and

a descrambler controller for controlling the descrambler to perform the descrambling operation by transferring the scrambling information corresponding to the ONT from the Ethernet-PON ONT function processor to the descrambler.

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3. (Original) The Ethernet-PON according to claim 2, wherein specific functions and initial states are assigned to the ONTs, respectively, to allow the respective scramblers and descramblers to perform the scrambling and descrambling operations.

4. (Original) The Ethernet-PON according to claim 3, wherein the scrambler for performing the scrambling operation based on the specific function and initial state includes:

a shift register for storing the initial state and performing a shift operation by the subsequent logical operations;

a first exclusive-OR gate for performing an exclusive-OR operation between element values of the shift register, and outputting the resulting value to an input of the shift register;

an AND gate for performing an AND operation between an output of the first exclusive-OR gate and an external enable signal; and

a second exclusive-OR gate for performing an exclusive-OR operation between input data and an output of the AND gate, and outputting the resulting value.

5. (Original) The Ethernet-PON according to claim 4, wherein the specific function is expressed by the following equation:

$$p(x) = c_n X^n + c_{n-1} X^{n-1} + \dots + c_2 X^2 + c_1 X^1 + 1,$$

where  $c_i$  is a constant of '0' or '1',  $x^i$  denotes the value of an  $i$ -th element of the

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shift register, and the constant *c* is set to '1' for elements of the shift register connected to the first exclusive-OR gate, and to '0' for the other elements of the shift register.

6. (Previously presented) The Ethernet-PON according to claim 1, wherein the OLT includes:

- a broadcast/image channel selection switch for receiving external MPEG (Motion Picture Experts Group) broadcast and image data, and switching and outputting said broadcast and image data on a user-by-user basis;

- a plurality of scramblers for scrambling broadcast/image channels outputted from the broadcast/image channel selection switch on a user-by-user basis;

- a multiplexer for receiving the scrambled broadcast/image signals from the plural scramblers, and combining them into a single broadcast/image signal;

- a first optical transmitter for optically modulating said single broadcast/image signal;

- an Ethernet-PON OLT function processor for performing Ethernet-PON OLT functions;

- a scrambler controller for controlling the plural scramblers according to respective broadcast/image selection information of the users from the Ethernet-PON OLT function processor;

- an IP router for routing communication data to an upper level IP network or to the Ethernet-PON OLT function processor;

- a second optical transmitter for optically modulating Ethernet communication data to be transmitted to the plural ONTs;

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a first optical receiver for receiving an optical signal from the plural ONTs, and converting into an electrical signal, and then transferring to the Ethernet-PON OLT function processor after its conversion, said optical signal from the plural ONTs that has been received;

a broadcast/image channel selection controller for receiving the broadcast/image selection information from the plural ONTs through the Ethernet-PON OLT function processor, and outputting a control signal to the broadcast/image channel selection switch so as to allow the switch to select broadcast/image channels corresponding respectively to the plural ONTs; and

a first wavelength division multiplexing (WDM) coupler for coupling an optically modulated Ethernet communication signal of wavelength  $\lambda_{\text{DOWN}}$  and an optically modulated broadcast/image signal of wavelength  $\lambda_{\text{B}}$ , and outputting the resulting signal.

7. (Previously presented) The Ethernet-PON according to claim 6, wherein each of the plurality of ONTs includes:

a second WDM coupler for separating an optical signal received from the OLT into an Ethernet communication signal of wavelength  $\lambda_{\text{DOWN}}$  and a broadcast/image signal of wavelength  $\lambda_{\text{B}}$ ;

a second optical receiver for receiving the separated Ethernet communication signal of wavelength  $\lambda_{\text{DOWN}}$ , and converting the signal of wavelength  $\lambda_{\text{DOWN}}$  into an electrical signal;

a third optical receiver for receiving the separated broadcast/image signal of wavelength  $\lambda_{\text{B}}$ , and converting into an electrical signal the received signal of wavelength

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$\lambda_B$ ;

an Ethernet-PON ONT function processor for performing ONT functions;

a third optical transmitter for receiving broadcast/image selection information and an Ethernet communication signal to be transmitted to the OLT from a corresponding user through the Ethernet-PON ONT function processor, and transmitting said broadcast/image selection information and a communication signal as an optical signal  $\lambda_{UP}$ ;

a broadcast/image channel selector & broadcast/image adapter for selecting a broadcast/image signal according to the broadcast/image selection information selected by the user, and recovering an associated original broadcast/image channel;

a descrambler for descrambling the broadcast/image signal recovered through the channel selector & broadcast/image adapter, and transferring the descrambled, recovered signal to the user; and

a descrambler controller for controlling the descrambler to perform the descrambling operation by transferring the scrambling information corresponding to the ONT from the Ethernet-PON ONT function processor to the descrambler.

8. (Original) The Ethernet-PON according to claim 7, wherein specific functions and initial states are assigned to the ONTs, respectively, to allow the respective scramblers and descramblers to perform the scrambling and descrambling operations.

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9. (Original) The Ethernet-PON according to claim 8, wherein the scrambler for performing the scrambling operation based on the specific function and initial state includes:

a shift register for storing the initial state and performing a shift operation by the subsequent logical operations;

a first exclusive-OR gate for performing an exclusive-OR operation between element values of the shift register, and outputting the resulting value to an input of the shift register;

an AND gate for performing an AND operation between an output of the first exclusive-OR gate and an external enable signal; and

a second exclusive-OR gate for performing an exclusive-OR operation between input data and an output of the AND gate, and outputting the resulting value.

10. (Original) The Ethernet-PON according to claim 9, wherein the specific function is expressed by the following equation:

$$p(x) = c_n X^n + c_{n-1} X^{n-1} + \dots + c_2 X^2 + c_1 X^1 + 1,$$

where  $c_i$  is a constant of '0' or '1',  $x^i$  denotes the value of an  $i$ -th element of the shift register, and the constant  $c$  is set to '1' for elements of the shift register connected to the first exclusive-OR gate, and to '0' for the other elements of the shift register.



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11. (Original) The Ethernet-PON according to claim 6, wherein the OLT further includes a multiplexer controller for controlling said multiplexer for receiving the scrambled broadcast/image signals to combine the scrambled broadcast/image signals into the single signal according to a time division multiplexing scheme.

12. (Previously presented) The Ethernet-PON according to claim 11, wherein each of the plurality of ONTs includes:

a second WDM coupler for separating an optical signal received from the OLT into an Ethernet communication signal of wavelength  $\lambda_{\text{DOWN}}$  and a broadcast/image signal of wavelength  $\lambda_{\text{B}}$ ;

a second optical receiver for receiving the separated Ethernet communication signal of wavelength  $\lambda_{\text{DOWN}}$ , and converting the signal of wavelength  $\lambda_{\text{DOWN}}$  into an electrical signal;

a third optical receiver for receiving the separated broadcast/image signal of wavelength  $\lambda_{\text{B}}$ , and converting into an electrical signal the received signal of wavelength  $\lambda_{\text{B}}$ ;

an Ethernet-PON ONT function processor for performing ONT functions;

a third optical transmitter for receiving broadcast/image selection information and an Ethernet communication signal to be transmitted to the OLT from a corresponding user through the Ethernet-PON ONT function processor, and transmitting said broadcast/image selection information and an Ethernet communication signal as an optical signal  $\lambda_{\text{UP}}$ ;

a broadcast/image channel selector & broadcast/image adapter for selecting a

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broadcast/image signal according to the broadcast/image selection information selected by the user, and recovering an associated original broadcast/image channel;

a descrambler for descrambling the broadcast/image signal recovered through the channel selector & broadcast/image adapter, and transferring the descrambled, recovered signal to the user; and

a descrambler controller for controlling the descrambler to perform the descrambling operation by transferring the scrambling information corresponding to the ONT from the Ethernet-PON ONT function processor to the descrambler.

13. (Original) The Ethernet-PON according to claim 12, wherein specific functions and initial states are assigned to the ONTs, respectively, to allow the respective scramblers and descramblers to perform the scrambling and descrambling operations.

14. (Original) The Ethernet-PON according to claim 13, wherein the scrambler for performing the scrambling operation based on the specific function and initial state includes:

a shift register for storing the initial state and performing a shift operation by the subsequent logical operations;

a first exclusive-OR gate for performing an exclusive-OR operation between element values of the shift register, and outputting the resulting value to an input of the shift register;

an AND gate for performing an AND operation between an output of the first

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exclusive-OR gate and an external enable signal; and

a second exclusive-OR gate for performing an exclusive-OR operation between input data and an output of the AND gate, and outputting the resulting value.

15. (Original) The Ethernet-PON according to claim 6, wherein the OLT further includes a multiplexer controller for controlling said multiplexer for receiving the scrambled broadcast/image signals to combine the scrambled broadcast/image signals into the single signal according to a frequency division multiplexing scheme.

16. (Previously presented) The Ethernet-PON according to claim 14, wherein the specific function is expressed by the following equation:

$$p(x) = c_n X^n + c_{n-1} X^{n-1} + \dots + c_2 X^2 + c_1 X^1 + 1,$$

where  $c_i$  is a constant of '0' or '1',  $x^i$  denotes the value of an  $i$ -th element of the shift register, and the constant  $c$  is set to '1' for elements of the shift register connected to the first exclusive-OR gate, and to '0' for the other elements of the shift register.

17. (Previously presented) The Ethernet-PON according to claim 15, wherein each of the plurality of ONTs includes:

a second WDM coupler for separating an optical signal received from the OLT into an Ethernet communication signal of wavelength  $\lambda_{\text{DOWN}}$  and a broadcast/image signal of wavelength  $\lambda_B$ ;

a second optical receiver for receiving the separated an Ethernet communication signal of wavelength  $\lambda_{\text{DOWN}}$ , and converting said signal of wavelength  $\lambda_{\text{DOWN}}$  into an

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electrical signal;

a third optical receiver for receiving the separated broadcast/image signal of  $\lambda_B$ ,  
and converting into an electrical signal said broadcast/image signal of  $\lambda_B$ ;

an Ethernet-PON ONT function processor for performing ONT functions;

a third optical transmitter for receiving broadcast/image selection information and  
an Ethernet communication signal to be transmitted to the OLT from a corresponding  
user through the Ethernet-PON ONT function processor, and transmitting as an optical  
signal  $\lambda_{UP}$  said broadcast/image selection information and an Ethernet communication  
signal;

a broadcast/image channel selector & broadcast/image adapter for selecting a  
broadcast/image signal according to the broadcast/image selection information selected  
by the user, and recovering an associated original broadcast/image channel;

a descrambler for descrambling the broadcast/image signal recovered through the  
channel selector & broadcast/image adapter, and transferring the descrambled, recovered  
signal to the user; and

a descrambler controller for controlling the descrambler to perform the  
descrambling operation by transferring the scrambling information corresponding to the  
ONT from the Ethernet-PON ONT function processor to the descrambler.

18. (Original) The Ethernet-PON according to claim 17, wherein specific  
functions and initial states are assigned to the ONTs, respectively, to allow the respective  
scramblers and descramblers to perform the scrambling and descrambling operations.

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19. (Original) The Ethernet-PON according to claim 18, wherein the scrambler for performing the scrambling operation based on the specific function and initial state includes:

a shift register for storing the initial state and performing a shift operation by the subsequent logical operations;

a first exclusive-OR gate for performing an exclusive-OR operation between element values of the shift register, and outputting the resulting value to an input of the shift register;

an AND gate for performing an AND operation between an output of the first exclusive-OR gate and an external enable signal; and

a second exclusive-OR gate for performing an exclusive-OR operation between input data and an output of the AND gate, and outputting the resulting value.

20. (Original) The Ethernet-PON according to claim 19, wherein the specific function is expressed by the following equation:

$$p(x) = c_n X^n + c_{n-1} X^{n-1} + \dots + c_2 X^2 + c_1 X^1 + 1,$$

where  $c_i$  is a constant of '0' or '1',  $x^i$  denotes the value of an  $i$ -th element of the shift register, the constant  $c$  is set to '1' for elements of the shift register connected to the first exclusive-OR gate, and to '0' for the other elements of the shift register.